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EFFECTS OF THE PECOS RIVER ON THE GEOGRAPHIC DISTRIBUTIONS OF MAMMALS IN WESTERN TEXAS

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It has been demonstrated that some rivers in North America are important physiographic features with regard to the geographic distributions of mammals (Grinnell, 1914; Goldman, 1937; Davis, 1939; Kelson, 1951; Findley and Anderson, 1956; Hoffmeister, 1971). In addition, some rivers serve as boundaries between distinctive ecological units and biogeographic regions.

From the southern Rocky Mountains, the Pecos River parallels the western edge of the Llano Estacado in eastern New Mexico. In Texas, the Pecos River flows for about 350 miles in a southeasterly direction from the New Mexico border to where it confluences with the Rio Grande between Comstock and Langtry in western Val Verde County at lake Amistad (Fig. 1). The upper valley of the river (Carlsbad-Iraan Subbasin) extends from the New Mexico-Texas border southward to the vicinity of McCamey and Iraan; the lower canyon (Iraan-Langtry Subbasin) is entrenched into the Edwards-Stockton Plateau (Leonard and Fry, 1962; Thomas, 1972).

The complex geologic history of the Pecos River was controlled by a sequence of tectonic events (Thomas, 1972). The upper portion of the river (Carlsbad-Iraan Subbasin) probably was formed in late Tertiary and early Pleistocene times (Thomas, 1972).

The lower portion of the river (Iraan-Langtry Subbasin) may have become entrenched into the Edwards-Stockton Plateau either during the Eocene (Thomas, 1972) or in the early Pleistocene (Leonard and Fry, 1962).

The middle portion of the Pecos River and associated valley was considered distinctive enough in land form and climate, that recognition as a unique physiographic unit was warranted (Fenneman, 1931). The Pecos River has been regarded generally as the southwestern boundary of the Great Plains (Graves and Meinzer, 1999). The river also was considered as the eastern boundary of the Chihuahuan Desert in the United States (Bryant, 1977; Wells, 1977; Schmidly, 1977a, 1977b; Johnson, 1979). In Texas, the Pecos River was designated as the primary boundary between the distinctive ecological units of the Trans-Pecos to the west and the Edwards Plateau to the east (Schmidly, 1977a). Also, Schmidly (1983) designated the Pecos River as the boundary between two of the major mammalian distributional regions (Trans-Pecos, Plains Country) recognized in Texas. Because the Pecos River is recognized as a boundary between diverse ecological regions, it may serve as either a biogeographic barrier or a filter zone for some of the unique mammalian faunas associated with those regions in Texas (Hollander, et al., 1990).

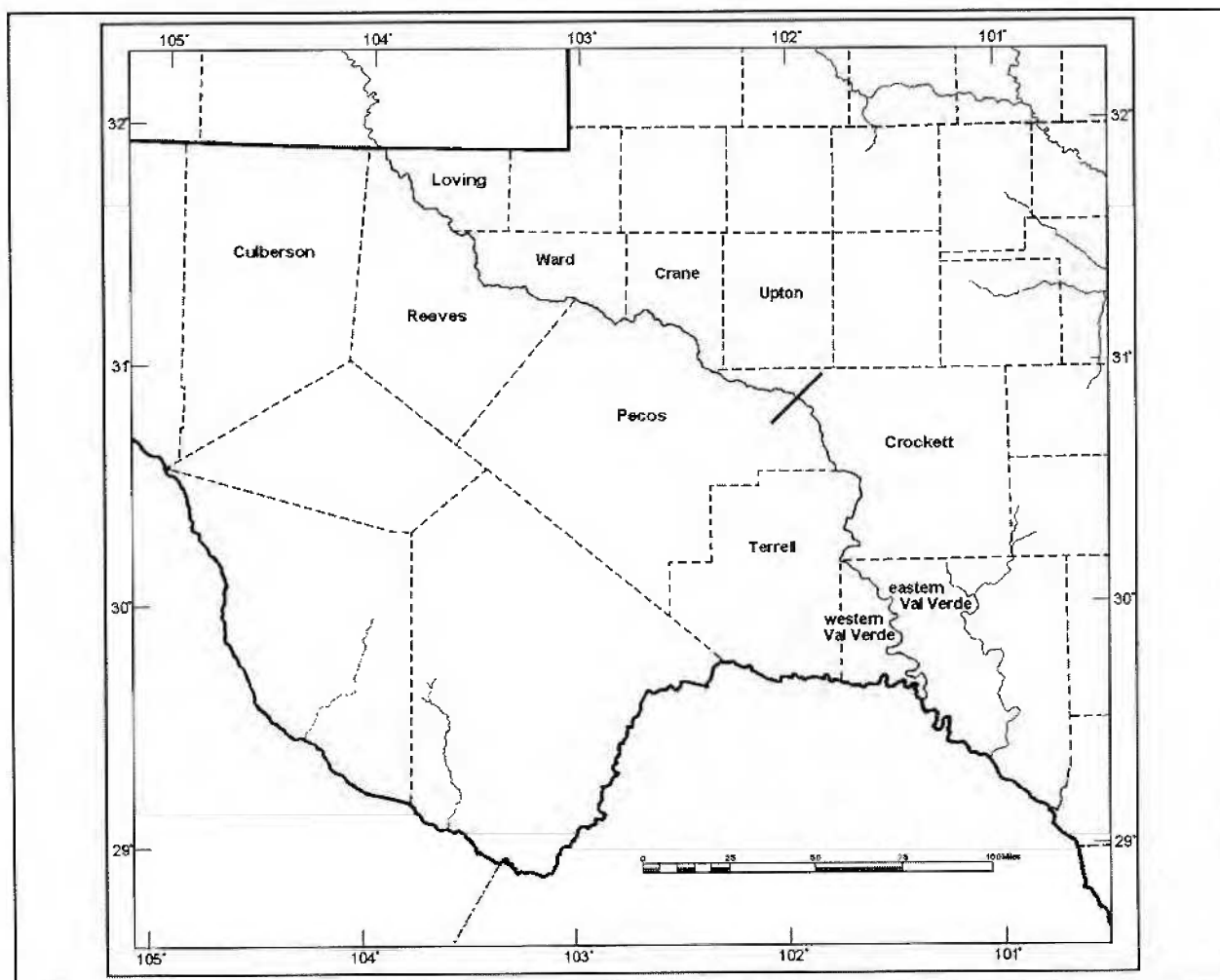


Figure 1. The Pecos River in Western Texas. The crossbar indicates the division between the upper valley (Carlsbad-Iraan Subbasin) and the lower canyon (Iraan-Langtry Subbasin). From north to south, counties on the west side of the river are Culberson, Reeves, Pecos, Terrell, and the western portion of Val Verde County. From north to south, counties on the east side of the river are Loving, Ward, Crane, Upton, Crockett, and the eastern portion of Val Verde County.

Records of distributions of mammals in the region of western Texas bisected by the Pecos River were obtained from the literature (Schmidly, 1977a, 1991; Geonoways and Baker, 1979; Hall, 1981; Davis and Schmidly, 1994; Stangl et al, 1994; Yancey, 1997; Goetze, 1998; Manning and Jones, 1998; and others). Information associated with specimens housed in the Collection of Recent Mammals in the Natural Science Research Laboratory of the Museum of Texas Tech University also was included in our examination of distributions of mammals in the region.

Inasmuch as the Pecos River is the boundary between the Trans-Pecos area and the Edwards Plateau in Texas, species of extant, native mammals known to occur in these major ecological regions are listed in Table 1. The Trans-Pecos region has 97 species of mammals; 79 species are known from the Edwards Plateau. Of these, 67 species are known to occur in both the Trans-Pecos area and on the Edwards Plateau. Twenty seven species occur in the Trans-Pecos area and not on the Edwards Plateau; whereas, 11 species of mammals known from the Edwards Plateau

Table 1. Extant, native mammals of the Trans-Pecos region and the Edwards Plateau of Texas. The presence of species of mammals in the areas is designated by an X.

Mammals	Trans-Pecos	Edwards Plateau	Mammals	Trans-Pecos	Edwards Plateau
Order Didelphimorphia			<i>Spermophilus variegatus</i>	X	X
Family Didelphidae			<i>Cynomys ludovicianus</i>	X	X
<i>Didelphis virginiana</i>	X	X	<i>Sciurus carolinensis</i>		X
Order Insectivora			<i>Sciurus niger</i>	X	X
Family Soricidae			Family Geomyidae		
<i>Cryptotis parva</i>		X	<i>Thomomys bottae</i>	X	X
<i>Notiosorex crawfordi</i>	X	X	<i>Geomys arenarius</i>	X	
Family Talpidae			<i>Geomys bursarius</i>		X
<i>Scalopus aquaticus</i>	X	X	<i>Geomys texensis</i>		X
Order Chiroptera			<i>Cratogeomys castanops</i>	X	X
Family Mormoopidae			Family Heteromyidae		
<i>Mormoops megalophylla</i>	X	X	<i>Perognathus flavescens</i>	X	
Family Phyllostomidae			<i>Perognathus flavus</i>	X	X
<i>Leptonycteris nivalis</i>	X		<i>Perognathus merriami</i>	X	X
<i>Diphylla ecaudata</i>		X	<i>Chaetodipus hispidus</i>	X	X
Family Vespertilionidae			<i>Chaetodipus eremicus</i>	X	X
<i>Myotis californicus</i>	X		<i>Chaetodipus intermedius</i>	X	
<i>Myotis ciliolabrum</i>	X		<i>Chaetodipus nelsoni</i>	X	X
<i>Myotis lucifugus</i>	X		<i>Dipodomys merriami</i>	X	X
<i>Myotis thysanodes</i>	X		<i>Dipodomys ordii</i>	X	X
<i>Myotis velifer</i>	X	X	<i>Dipodomys spectabilis</i>	X	
<i>Myotis volans</i>	X		Family Castoridae		
<i>Myotis yumanensis</i>	X	X	<i>Castor canadensis</i>	X	X
<i>Lasionycteris noctivagans</i>	X	X	Family Muridae		
<i>Pipistrellus hesperus</i>	X	X	<i>Reithrodontomys fulvescens</i>	X	X
<i>Pipistrellus subflavus</i>	X	X	<i>Reithrodontomys megalotis</i>	X	X
<i>Eptesicus fuscus</i>	X	X	<i>Reithrodontomys montanus</i>	X	X
<i>Lasiurus blossevilli</i>	X		<i>Peromyscus attwateri</i>	X	X
<i>Lasiurus borealis</i>	X	X	<i>Peromyscus boylii</i>	X	
<i>Lasiurus cinereus</i>	X	X	<i>Peromyscus nasutus</i>	X	
<i>Lasiurus intermedius</i>	X	X	<i>Peromyscus eremicus</i>	X	X
<i>Lasiurus xanthinus</i>	X		<i>Peromyscus leucopus</i>	X	X
<i>Nycticeius humeralis</i>	X	X	<i>Peromyscus maniculatus</i>	X	X
<i>Euderma maculatum</i>	X		<i>Peromyscus pectoralis</i>	X	X
<i>Plecotus townsendii</i>	X	X	<i>Peromyscus truei</i>	X	
<i>Antrozous pallidus</i>	X	X	<i>Baiomys taylori</i>		X
Family Molossidae			<i>Onychomys arenicola</i>	X	X
<i>Tadarida brasiliensis</i>	X	X	<i>Onychomys leucogaster</i>	X	X
<i>Nyctinomops femorosaccus</i>	X		<i>Sigmodon fulviventer</i>	X	
<i>Nyctinomops macrotis</i>	X		<i>Sigmodon hispidus</i>	X	X
<i>Eumops perotis</i>	X		<i>Sigmodon ochrognathus</i>	X	
Order Xenarthra			<i>Neotoma albigula</i>	X	X
Family Dasypodidae			<i>Neotoma floridana</i>	X	X
<i>Dasypus novemcinctus</i>	X	X	<i>Neotoma micropus</i>	X	X
Order Lagomorpha			<i>Neotoma mexicana</i>	X	
Family Leporidae			<i>Microtus mexicanus</i>	X	
<i>Sylvilagus aquaticus</i>		X	<i>Microtus pinetorum</i>		X
<i>Sylvilagus audubonii</i>	X	X	<i>Ondatra zibethicus</i>	X	X
<i>Sylvilagus floridanus</i>	X	X	Family Erethizontidae		
<i>Sylvilagus robustus</i>	X		<i>Erethizon dorsatum</i>	X	X
<i>Lepus californicus</i>	X	X	Order Carnivora		
Order Rodentia			Family Canidae		
Family Sciuridae			<i>Canis latrans</i>	X	X
<i>Tamias canipes</i>	X		<i>Vulpes macrotis</i>	X	
<i>Ammospermophilus interpres</i>	X	X	<i>Vulpes vulpes</i>	X	X
<i>Spermophilus mexicanus</i>	X	X	<i>Urocyon cinereoargenteus</i>	X	X

Table 1. cont.

Mammals	Trans-Pecos	Edwards Plateau
Family Ursidae		
<i>Ursus americanus</i>	X	
Family Procyonidae		
<i>Bassariscus astutus</i>	X	X
<i>Procyon lotor</i>	X	X
<i>Nasua narica</i>	X	X
Family Mustelidae		
<i>Mustela frenata</i>	X	X
<i>Mustela vison</i>		X
<i>Taxidea taxus</i>	X	X
Family Mephitidae		
<i>Spilogale gracilis</i>	X	X
<i>Mephitis macroura</i>		X
<i>Mephitis mephitis</i>	X	X
<i>Conepatus mesoleucus</i>	X	X
Family Felidae		
<i>Leopardus pardalis</i>	X	X
<i>Lynx rufus</i>	X	X
<i>Puma concolor</i>	X	X
Order Artiodactyla		
Family Tayassuidae		
<i>Pecari tajacu</i>	X	X
Family Cervidae		
<i>Cervus elaphus</i>	X	
<i>Odocoileus hemionus</i>	X	
<i>Odocoileus virginianus</i>	X	X
Family Antilocapridae		
<i>Antilocapra americana</i>	X	X

are not recorded from the Trans-Pecos region. Some species, such as *Tamias canipes* and *Microtus mexicanus*, listed for the Trans-Pecos occur only in the Guadalupe Mountains (Genoways et al., 1979). In both areas, there are some extralimital records of distributions of mammals, such as *Myotis lucifugus* in the Trans-Pecos and *Diphylla ecaudata* on the Edwards Plateau (Schmidly, 1991).

The differences in the richness of the mammalian faunas of the two regions may be explained in several ways. Topographic features and corresponding habitats are more diverse in the Trans-Pecos area than those of the Edwards Plateau. For example, some montane areas of the Trans-Pecos surrounded by Chihuahuan Desert vegetation result in considerable diversity of habitats. In general, areas with large ranges in elevations tend to have greater species diversity than those comprised of lower variability of elevations (Williamson, 1981). Furthermore, Goetze (1998) found a rather strong affinity between the mammalian fauna

on the Edwards Plateau with those of the Llano Estacado and the Rolling Plains regions of Texas. This relationship was noticed by Schmidly (1983), who suggested a combination of the Llano Estacado, Rolling Plains, and Edwards Plateau into a Plains Region. In the Trans-Pecos region, mammalian faunas of the montane areas have closer affinities to each other than to the faunas of other areas (Genoways et al., 1979; Stangl et al., 1994). Mammals of some of the lowland, Chihuahuan Desert areas in the Trans-Pecos region have some levels of similarity to the mammalian faunas of Chihuahua and Coahuila, Mexico (Yancey, 1997). However, Chihuahua and Coahuila are separated from the Trans-Pecos area by the Rio Grande, which has been indicated as an important filter barrier to the dispersal of Chihuahuan Desert mammals (Schmidly, 1977b, Yancey, 1997).

In order to examine more closely the importance of the Pecos River with regard to geographic distributions of mammals, we assembled information on the presence of species of extant, native mammals known to occur in the counties of Texas adjacent to the river (Table 2). Some of this information is similar to the data given by Hollander et al. (1990); however, we included all species of mammals known from the areas adjacent to the river. Twelve species of mammals occur in the counties just west of the Pecos River; 11 species have been recorded from the counties just east of the river. Species of mammals known to occur in at least some of the counties on both sides of the Pecos River total 61 (Table 2). Of the 84 species of mammals listed in Table 2, the known distributional limits of 23 species are at either the west or east side of the Pecos River.

Of the species of mammals with known geographic ranges in the Trans-Pecos area west of the Pecos River that occur also in the region east of the river, 21 species are represented by different subspecies, at least in part, on the two sides of the river (Table 3). It is important to note, however, that some species of mammals with broad distributions in Texas are known from the Trans-Pecos region based on single specimens captured one time at one locality. For example, for some information on the presence of *Scalopus aquaticus* and *Pipistrellus subflavus* in the Trans-Pecos area, see the comments by Hollander et

al., (1990), Yancey et al. (1997), Yancey (1997), and Manning and Jones (1998). Distribution of subspecies of some mammals, such as *Odocoileus virginianus*, may have been changed as a result of relocation or restocking. Delineation of geographic ranges of subspecies of some mammals in the area is tenuous, at best, because of lack of appropriate information. The Holocene mammalian fauna of the region in general and the Trans-Pecos in particular is in a dynamic state (Stangl, 1994). For example, several taxa of mammals unknown previously to occur in the Trans-Pecos have been reported recently (Stangl, 1992); Yancey et al., 1995; Bradley et al., 1999; Dowler et al., 1999; Higginbotham et al., 1999; Jones et al., 1999).

There is general agreement that the present system of the Pecos River became established in the Pleistocene (Leonard and Fry, 1962; Thomas, 1972). At that time, when the upper portion of the river was becoming a southeasterly-heading, eroding stream and the southern portion was entrenching, the Pecos River may have been a major barrier to the dispersal of mammals (Leonard and Fry, 1962; Thomas, 1972). For example, Hollander et al. (1990) suggested that the river was a major factor during the Pleistocene in the creation of a hiatus in the geographic distribution of *Scalopus aquaticus* in this area of Texas. The probable function of the Pecos River as a major barrier to the dispersal of mammals is indicated, at least in part, by the differences in the mammalian faunas on either side of the river (Tables 1-3).

In historic time, during the early exploration and settlement in the region, the Pecos River was a major, flowing stream. Reports by early travelers in the area described the river as "anywhere from 40 to 100 feet wide and four to 15 feet deep with a strong, fast, turbid current" (Graves and Meinzer, 1999). The lower canyon area of the river mostly was avoided in the establishment of travel and trade routes; travelers relied on crossings of the Pecos River near the New

Mexico-Texas border (Jacobson and Nored, 1993; Graves and Meinzer, 1999). For some additional details on the hazards of crossing the Pecos River, as well as some photographs and descriptions of the crossings, see the work by Dearen (1996).

At the present time, the Pecos River is a rather sluggish, highly mineralized stream, especially in the upper portion; rapids are still present in the lower canyon (Graves and Meinzer, 1999). The reduction of flow of water in the river probably is the result of development of reservoirs, such as Red Bluff Lake just below the New Mexico-Texas border, as well as some additional impoundments upstream, interception of the water for irrigation, changing land-use patterns, and cyclic climatic events. Some changes in the vegetation adjacent to the river have occurred, as well. For example, although honey mesquite (*Prosopis glandulosa*) and desertwillow (*Chilopsis linearis*) are common trees along parts of the river, the introduced salt cedar (*Tamarix sp.*) is thick along the Pecos River and is choking out the upper half of the river (Powell, 1988).

The Pecos River is an important feature with regard to the geographic distributions of mammals. The lower canyon apparently has had more impact on the geographic distributions of mammals in the area than has the upper section of the river. Based on the analyses of the data available, it seems warranted to suggest that the formation of the Pecos River was a vicariance event that was important with regard to the subsequent evolution and development of patterns of distributions of the Recent mammals in western Texas. As implied previously, the influence of the Pecos River on geographic distributions of mammals seemingly has diminished in historic times. Details of presence and distributions of mammals, as well as relationships among and between the mammals in the area in general and the Trans-Pecos in particular are imperfectly known.

Table 2. Extant, native mammals known to occur in counties of Texas adjacent to the Pecos River. From north to south, counties west of the river are Culberson, Reeves, Pecos, Terrell, and the western portion of Val Verde County. From north to south, counties east of the river include Loving, Ward, Crane, Upton, Crockett, and eastern Val Verde County. See Figure 1. Presence of taxa of mammals in the areas is designated by an X. Species marked with an * do not occur either in the Trans-Pecos region or on the Edwards Plateau, but range into some of the aforementioned counties on the east side of the Pecos River.

Mammals	Pecos River		
	West Side	East Side	Both Sides
Order Didelphimorphia			
Family Didelphidae			
<i>Didelphis virginiana</i>			X
Order Insectivora			
Family Soricidae			
<i>Cryptotis parva</i>		X	
<i>Notiosorex crawfordi</i>			X
Order Chiroptera			
Family Mormoopidae			
<i>Mormoops megalophylla</i>		X	
Family Phyllostomidae			
<i>Leptonycteris nivalis</i>		X	
<i>Diphylla ecaudata</i>		X	
Family Vespertilionidae			
<i>Myotis californicus</i>	X		
<i>Myotis ciliolabrum</i>	X		
<i>Myotis thysanodes</i>	X		
<i>Myotis velifer</i>			X
<i>Myotis volans</i>	X		
<i>Myotis yumanensis</i>			X
<i>Lasionycteris noctivagans</i>	X		
<i>Pipistrellus hesperus</i>			X
<i>Pipistrellus subflavus</i>		X	
<i>Eptesicus fuscus</i>	X		
<i>Lasiurus borealis</i>		X	
<i>Lasiurus cinereus</i>			X
<i>Plecotus townsendii</i>			X
<i>Antrozous pallidus</i>			X
Family Molossidae			
<i>Tadarida brasiliensis</i>			X
<i>Nyctinomops macrotis</i>	X		
<i>Eumops perotis</i>	X		
Order Xenarthra			
Family Dasypodidae			
<i>Dasypus novemcinctus</i>			X
Order Lagomorpha			
Family Leporidae			
<i>Sylvilagus audubonii</i>			X
<i>Sylvilagus floridanus</i>			X
<i>Lepus californicus</i>			X
Order Rodentia			
Family Sciuridae			
<i>Ammospermophilus interpres</i>			X
<i>Spermophilus mexicanus</i>			X
<i>Spermophilus pilosoma</i>			X

Table 2. cont.

Mammals	Pecos River		
	West Side	East Side	Both Sides
<i>Spermophilus variegatus</i>			X
<i>Cynomys ludovicianus</i>			X
<i>Sciurus niger</i>			X
Family Geomyidae			
<i>Thomomys bottae</i>			X
<i>Geomys knoxjonesi</i> *		X	
<i>Geomys personatus</i> *		X	
<i>Cratogeomys castanops</i>			X
Family Heteromyidae			
<i>Perognathus flavescens</i>		X	
<i>Perognathus flavus</i>	X		
<i>Perognathus merriami</i>			X
<i>Chaetodipus hispidus</i>			X
<i>Chaetodipus eremicus</i>			X
<i>Chaetodipus intermedius</i>			X
<i>Chaetodipus nelsoni</i>			X
<i>Dipodomys merriami</i>			X
<i>Dipodomys ordii</i>			X
<i>Dipodomys spectabilis</i>			X
Family Castoridae			
<i>Castor canadensis</i>			X
Family Muridae			
<i>Reithrodontomys fulvescens</i>			X
<i>Reithrodontomys megalotis</i>			X
<i>Reithrodontomys montanus</i>			X
<i>Peromyscus attwateri</i>		X	
<i>Peromyscus boylii</i>	X		
<i>Peromyscus eremicus</i>			X
<i>Peromyscus leucopus</i>			X
<i>Peromyscus maniculatus</i>			X
<i>Peromyscus nasutus</i>		X	
<i>Peromyscus pectoralis</i>			X
<i>Baionys taylori</i>		X	
<i>Onychomys arenicola</i>			X
<i>Onychomys leucogaster</i>			X
<i>Sigmodon hispidus</i>			X
<i>Neotoma albigula</i>			X
<i>Neotoma micropus</i>			X
<i>Ondatra zibethicus</i>			X
Family Erethizontidae			
<i>Erethizon dorsatum</i>			X
Order Carnivora			
Family Canidae			
<i>Canis latrans</i>			X
<i>Vulpes macrotis</i>			X
<i>Vulpes vulpes</i>			X
<i>Urocyon cinereoargenteus</i>			X
Family Procyonidae			
<i>Bassariscus astutus</i>			X
<i>Procyon lotor</i>			X

Table 2 cont.

Mammals	Pecos River		
	West Side	East Side	Both Sides
Family Mustelidae			
<i>Mustela frenata</i>			X
<i>Taxidea taxus</i>			X
Family Mephitidae			
<i>Spilogale gracilis</i>			X
<i>Mephitis macroura</i>		X	
<i>Mephitis mephitis</i>			X
<i>Conepatus mesoleucus</i>			X
Family Felidae			
<i>Lynx rufus</i>			X
<i>Puma concolor</i>			X
Order Artiodactyla			
Family Tayassuidae			
<i>Pecari tajacu</i>			X
Family Cervidae			
<i>Odocoileus hemionus</i>			X
<i>Odocoileus virginianus</i>			X
Family Antilocapridae			
<i>Antilocapra americana</i>			X

Table 3. Extant, native mammals that are represented by different subspecies on the two sides of the Pecos River.

Order Insectivora	Family Castoridae
Family Talpidae	<i>Castor canadensis</i>
<i>Scalopus aquaticus</i>	Family Muridae
Order Chiroptera	<i>Reithrodontomys fulvescens</i>
Family Vespertilionidae	<i>Reithrodontomys montanus</i>
<i>Pipistrellus subflavus</i>	<i>Peromyscus leucopus</i>
Order Lagomorpha	<i>Peromyscus maniculatus</i>
Family Leporidae	<i>Neotoma albigula</i>
<i>Sylvilagus audubonii</i>	<i>Neotoma micropus</i>
Order Rodentia	<i>Onychomys leucogaster</i>
Family Sciuridae	Order Carnivora
<i>Spermophilus spilosoma</i>	Family Procyonidae
<i>Spermophilus variegatus</i>	<i>Procyon lotor</i>
<i>Cynomys ludovicianus</i>	Order Artiodactyla
Family Geomyidae	Family Cervidae
<i>Thomomys bottae</i>	<i>Odocoileus virginianus</i>
<i>Cratogeomys castanops</i>	
Family Heteromyidae	
<i>Perognathus flavescens</i>	
<i>Chaetodipus hispidus</i>	
<i>Dipodomys ordii</i>	

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LITERATURE CITED

- Bradley, R. D., D. S. Carroll, M. L. Clary, C. W. Edwards, I. Tiemann-Boege, M. J. Hamilton, R. A. Van Den Bussche, and C. Jones. 1999. Comments on some small mammals from the Big Bend and Trans-Pecos regions of Texas. *Occasional Papers, Museum of Texas Tech University*, 193:1-6.
- Bryant, V. M., Jr. 1977. Late Quaternary pollen records from the east-central periphery of the Chihuahuan Desert. Pp. 3-21 *in* Transactions of the symposium on the biological resources of the Chihuahuan Desert region, United States and Mexico (R. H. Wauer and D. H. Riskind, eds.). U.S. Department of Interior, National Park Service, Proceedings and Transactions Series, 3:xxii + 1-658.
- Davis, W. B. 1939. The Recent mammals of Idaho. Claxton Printers, Ltd., Caldwell, Idaho, 400 pp.
- Davis, W. B., and D. J. Schmidly. 1994. The mammals of Texas: Texas Parks and Wildlife Department, Austin, x + 1-338.
- Dearen, P. 1996. Crossing Rio Pecos. Texas Christian University Press, Fort Worth, x + 1-196.
- Dowler, R. C., R. C. Dawkins, and T. C. Maxwell. 1999. Range extensions for the evening bat (*Nycticeius humeralis*) in West Texas. *Texas Journal of Science*, 51:193-195.
- Fenneman, N. M. 1931. Physiography of western United States. McGraw-Hill Book Company, Inc., New York, xiii + 1-534.
- Findley, J. S., and S. Anderson. 1956. Zoogeography of the montane mammals of Colorado. *Journal of Mammalogy*, 37:80-82.
- Genoways, H. H., and R. J. Baker (eds.). 1979. Biological investigations in the Guadalupe Mountains National Park, Texas. U.S. Department of Interior, National Park Service, Proceedings and Transactions Series, 4:xvii + 1-442.
- Genoways, H. H., R. J. Baker, and J. E. Cornely. 1979. Mammals of the Guadalupe Mountains National Park, Texas. Pp. 271-332 *in* Biological investigations in Guadalupe Mountains National Park, Texas (H. H. Genoways and R. J. Baker eds.). U.S. Department of Interior, National Park Service, Proceedings and Transactions Series, 4:xvii + 1-442.
- Goldman, E. A. 1937. The Colorado River as a barrier in mammalian distribution. *Journal of Mammalogy*, 18:427-435.
- Goetze, J. R. 1998. The mammals of the Edwards Plateau, Texas. Special Publication, Museum of Texas Tech University, 41:1-263.
- Graves, J., and W. Meinzer. 1999. The Pecos. *Texas Parks and Wildlife*, December, 1999:19-27.
- Grinnell, J. 1914. An account of the mammals and birds of the lower Colorado Valley with especial reference to the distributional problems presented. University of California Publications in Zoology, 12:51-294.
- Hall, E. R. 1981. The mammals of North America, John Wiley & Sons, New York, 2nd ed., 1:xv + 1-600 + 90 and 2:vi + 601 - 1181 + 90.
- Higginbotham, J. L., L. K. Ammerman, and M. T. Dixon. 1999. First record of *Lasiurus xanthinus* (Chiroptera: Vespertilionidae) in Texas. *Southwestern Naturalist*, 44:343-347.

- Hoffmeister, D. F. 1971. Mammals of Grand Canyon. University of Illinois Press, Urbana, 183 pp.
- Hollander, R. R., C. Jones, J. K. Jones, Jr., and R. W. Manning. 1990. Preliminary analysis of the effects of the Pecos River on geographic distribution of small mammals in western Texas. *Journal of Big Bend Studies*, 2:97-107.
- Jacobson, L. M., and M. B. Nored. 1993. Jeff Davis County, Texas. Fort Davis Historical Society, Inc., xii + 1-676.
- Johnson, M. C. 1979. The Guadalupe Mountains—a chink in the mosaic of the Chihuahuan Desert. Pp. 45-49 in *Biological investigations in the Guadalupe Mountains National Park, Texas* (H. H. Genoways and R. J. Baker, eds.). U.S. Department of Interior, National Park Service, Proceedings and Transactions Series, 4:xvii + 1-442.
- Jones, C., L. Hedges, and K. Bryan. 1999. The western yellow bat, *Lasiurus xanthinus* (Chiroptera: Vespertilionidae), from the Davis Mountains, Texas. *Texas Journal of Science*, 51:267-269.
- Kelson, K. R. 1951. Speciation of rodents of the Colorado River drainage. University of Utah Biological Series, 11:vii + 125.
- Leonard, A. B., and J. C. Frye. 1962. Pleistocene molluscan faunas and physiographic history of Pecos Valley in Texas. University of Texas Bureau of Economic Geology, Report and Inventory, 45:1-42.
- Manning, R. W., and C. Jones. 1998. Annotated checklist of Recent land mammals of Texas, 1998. Occasional Papers, Museum of Texas Tech University, 182:1-19.
- Powell, A. M. 1988. Trees & shrubs of Trans-Pecos Texas including Big Bend and Guadalupe Mountains National Parks. Big Bend Natural History Association, Big Bend, Texas, 536 pp.
- Schmidly, D. J. 1977a. The mammals of Trans-Pecos Texas including Big Bend National Park and Guadalupe Mountains National Park. Texas A&M University Press, College Station, xiii + 1-225.
- Schmidly, D. J. 1977b. Factors governing the distribution of mammals in the Chihuahuan Desert region. Pp. 163-192 in *Transactions of the symposium on the biological resources of the Chihuahuan Desert region, United States and Mexico* (R. H. Wauer and D. H. Riskind, eds.). U.S. Department of Interior, National Park Service, Proceedings and Transactions Series, 3:xxii + 1-658.
- Schmidly, D. J. 1983. Texas mammals east of the Balcones Fault Zone. Texas A&M University Press, College Station, xvii + 1-400.
- Schmidly, D. J. 1991. The bats of Texas. Texas A&M University Press, College Station, xviii + 1-188.
- Stangl, F. B., Jr. 1992. A new subspecies of the tawny-bellied cotton rat, *Sigmodon fulviventris*, from Trans-Pecos Texas. Occasional Papers, Museum of Texas Tech University, 145:1-4.
- Stangl, F. B., Jr., W. W. Dalquest, and R. R. Hollander. 1994. Evolution of a desert mammalian fauna: a 10,000-year history of mammals from Culberson and Jeff Davis counties, Trans-Pecos Texas. Midwestern State University Press, Wichita Falls, Texas, xix + 1-264.
- Thomas, R. G. 1972. The geomorphic evolution of the Pecos River system. *Baylor Geological Studies Bulletin*, 22:1-40.
- Wells, P. V. 1977. Post-glacial origin of the present Chihuahuan Desert less than 11,500 years ago. Pp. 67-83 in *Transactions of the symposium on the biological resources of the Chihuahuan Desert region, United States and Mexico* (R. H. Wauer and R. H. Riskind, eds.). U.S. Department of Interior, National Park Service, Proceedings and Transactions Series, 3:xxii + 1-658.
- Williamson, M. 1981. Island populations. Oxford University Press, Oxford, England, xi + 1-268.
- Yancey, F. D., II. 1997. The mammals of Big Bend Ranch State Park, Texas. Special Publications, Museum of Texas Tech University, 39:1-210.

- Yancey, F. D., II, C. Jones, and R. W. Manning. 1995.
The eastern pipistrelle, *Pipistrellus subflavus*
(Chiroptera: Vespertilionidae), from the Big
Bend region of Texas. Texas Journal of Sci-
ence, 47:229-231.

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